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Climate for Innovation in Public Funded R&D Laboratory

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Abstract

Putting creativity to use is a simple way to define innovation. It is being used to establish or improve technology, process, services or market in many organizations. Now a day's innovation is considered essential for improving efficiency and sustainability. As there was hardly any literature available in Indian context for public R&D sector, the present work was taken up in a government funded laboratory in India with an aim to study organization climate in the laboratory for innovation. In other words this paper studies the role of organizational climate for innovation. Fostering innovation is expected to further improve project management efficiency, combat internal competition, technology readiness for future, retention of talent etc. A specific organizational climate is essential even for R&D Institution to foster innovation. The present research paper describes the organizational climate defined by unique combination of sixteen determinants required for technological innovation in a government run R&D laboratory. This innovation climate model is proposed based on literature review both for organizational climate determinants and also for measure of innovation. Out of the 23 factors compiled from the literature, the final 16 determinants were shortlisted based on survey amongst the scientists, project leaders and experts based on the response. The 16 determinant/scale model for organization climate is tried at an intermediate stage in the laboratory and is able to explain innovation to a satisfactory extent. This study has considered three aspects of innovation as other than the proposed model, the study is also supported by secondary data in the form of a few innovation markers of the laboratory like number of research papers, academics collaborations, training, national recognition etc. and also real time case studies from analysis of a few projects developed by the laboratory in recent past to compare. Case studies have also validated that various identified determinants have important role in nurturing the organizational climate for innovation.

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Keywords: Case Study, Determinants, Government, Innovation, Innovation Markers, Organizational Climate, R&D

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1. Introduction

Most of the organizations today combat a dynamic environment, accordingly, organization needs to be more innovative than before to compete, to survive, to grow, to lead and to succeed (Gunusluoglu, 2009). To be successful, change is must (Vazifeh, 2011) and govt. R&D laboratories are no exception to it. R&D employees are considered to be more innovative than others. Additionally, the organizations are continually under competitive pressures and are forced to re-evaluate & consider innovations. Innovation has always been essential for the organizations' long-term survival & growth and currently play even more crucial role in the future to follow the rapid pace of evolution (Vijande, 2007). Innovation (Lone, 2011) is considered essential for efficiency and survival (Jansen, 2004). Companies consider innovation as the key to improve profit and market. Governments emphasize innovation in their attempts to create a competitive economy (Baer and Frese, 2003) and the European Union places innovation at the heart of its ten year strategy known as Europe 2020 (European Commission, 2011). Business and technological changes also are threatening sustainability and modern management faces many challenges (Koc, 2007). Therefore, becoming an innovative organization is a means to compete in this dynamic and changing business environment (Dooley, 2003). One of the most serious challenges which, a high-technology organization are facing is how to manage innovation as the organization evolves (Koberg, 1999). It is apparent that in order to satisfy the customer's unlimited expectations, companies need to orient themselves to their customer's wants, as well as latent needs (Soltani iraj et al., 2011) and as a result provide valuable products and services.

A combination of innovative ideas and good organizational innovation management (OIM) is the key to sustaining competitive organizational innovation in the long term (Ahmed, 1998). In the present study in a public funded R&D laboratory in the country the organizational climate parameters were selected from literature and customized for the laboratory based on survey. This scale was used to collect the data on organization climate and similarly data was collected on innovation through another scale. Based on the data collected a model is suggested. The independent variable of organization climates for innovation was also validated through case study based on projects done. From this study it is felt that laboratory is moving on the path of Innovation in recent years. This makes it more important to analyze the determinants of the prevailing climate at the laboratory with an aim to further refine the organizational climate for innovation.

2.0 Review of Literature

2.1 Organizational Climate

The term "organizational climate" can be understood as "a set of measurable properties of the work environment, based on the collective perception of the people who live and work in the environment and demonstrate to influence their motivation and behavior." It describes the way it feels to work in an organization. People use "climate" as a phrase to describe the overall "work atmosphere" of an organization. Simply stated, climate is people's perception of the environment in which they work. Organizational climate has been researched and studied extensively since 1967. (Litwin and Stringer, 1968, as cited in Al-Shammari, 1992), defined organizational climate as "a set of measurable properties of the work environment and assumed to influence their motivation and behavior". As per (Ekvall, 1991), climate acts as an intervening variable in an organization. Climate influences and is subsequently influenced by the outcome of organizational operations. Climate affects outcomes by influencing organizational processes such as problem solving, decision making, communicating and coordinating, the individual processes of learning & creating, and levels of motivation & commitment. These, in turn, influence the ways in which the organization uses its resources viz. men, infrastructure, intellectual property and finance.

2.2 Determinants/Factors of Organization Climate

An initial assumption in the area of organizational climate could be characterized by number of factors. In literature, there are many frameworks describing the determinants to study organizational climate. Based on the literature, determinants were identified within each of the four broadly conceptualized domains – Human Relations,

Internal process, Open systems and Rational Goal. In order to identify subscales or parameters that reflected each of these four domains, the literatures were searched to develop such a comprehensive set of dimensions aiming at innovation. The 23 identified dimensions are those which have been frequently utilized in research studies in past and also felt necessary for R&D environment under study as given in table 1. The literature in support of the determinants is furnished in table 2.

Table 1 - Determinant for organizational climate

S. No	Determinants	Response (in per cent) (n=130)
1.	Autonomy (AN)	82
2.	Integration (INT)	87
3.	Involvement (INV)	90
4.	Supervisory Support (SS)	91
5.	Training (TRG)	85
6.	Welfare (WEF)	68
7.	Formalization (FMZ)	85
8.	Tradition (TRD)	82
9.	Flexibility (F)	89
10.	Outward Focus (OF)	86
11.	Reflexivity (RFY)	85
12.	Clarity of Organizational Goals (OG)	90
13.	Efficiency (EFY)	88
14.	Efforts (EFT)	88
15.	Performance feedback (PFB)	87
16.	Pressure to produce(PP)	87
17.	Quality (QT)	88
18.	Reward	72
19.	Risk Taking	75
20.	Trust/Openlessness	75
21.	Challenge	68
22.	Play fullness/humor	71
23.	Standard	76

3. **Methodology**

3.1 Short listing of Climatic Parameters

23 determinants of organizational climate were compiled from the literature, based on their frequent utilization in various studies and necessity for R&D environment under study. Out of 23, the final 16 determinants were decided based on discussions amongst the scientists, project leaders & experts and also agreement by most of the respondents (more than 80%) through a survey. For final survey, accordingly 7 parameters were dropped. This may be due to the fact that they are otherwise overlapping with other parameter viz. Managerial trust, Trust/Openness, recognition & reward are covered under performance feedback, goal and mission clarity are covered under clarity of organization goal intellectual simulation and idea support is covered under flexibility commitment & participation are covered under involvement, freedom is covered under autonomy, positive interpersonal exchange is covered under integration, positive supervisory relation and support are covered under supervisory support, product emphasis is covered under quality; Harmony, Communication & Open mindlessness are covered under tradition and work group cooperation with existing factors viz. Tradition & Integration. Considering the remaining set of 16 parameters which are almost matching with the parameter given in OCM (Patterson et al.,,,, 2005) was found most comprehensive and suitable for our purpose of study. The sixteen parameters under study are divided in four domains as mentioned above in table 2. The literature in support of these identified parameters is also summarized in table 2.

Table 2 - literature in support of organizational climate determinants for innovation

Determinants along with count of citations	Researchers
A. Human Relation	
Autonomy (AN) (9)	Hunter *et al.,* 2007; Campbell, Dunnotte et al., 1970; Patterson *et al.* ,2005; James & James, 1989; James & Mcintyre 1996; James & Sells, 1981; Lone Jon Ander et al., 2011; Amabile et al., 1996; Mishra & Shrinivasan, 2008.
Integration (INT) (8)	Amabile, 1988; Scott William, 2001; Martin et al., 2003; Morris, 2005; Hassan et al.,, 2006; Dixit Gopal Krishna, 2011;Patterson *et al.,.,,*2005; Lone Jon Ander et al., 2011.
Involvement (INV) (3)	Hunter *et al.,* 2007; Jon Anders Lone, 2011;Patterson *et al.,*2005
Supervisory Support (SS) (6)	Kimberley *et al.,*1981; Kimberley and Evanisko, 1981; Hunter *et al.,*2007; Teresa, 1973 ; Patterson *et al.,*2005; Lone Jon Ander et al.,2011.
Training (TRG) (6)	Gattiker, 1995; Morrow *et al.,*2000; ;Patterson *et al.,*2005, Lange et al., 2000, Oyelaran 2010, Dixit Gopal Krishna et al., 2011
B. Internal Process	
Formalization(FMZ) (3)	Pugh *et al.,.,,* 1968;Patterson *et al.,*2005, , Lone Jon Ander et al.,., 2011.
Tradition (TRD) (3)	Coch and French, 1948; Patterson *et al.*2005; Lone Jon Ander et al., 2011.
C. Open Systems	
Flexibility (F) (5)	Garrahan & Stewart, 1992; King & Anderson, 1995; Hunter, 2007; Patterson et al., 2005; Lone Jon Ander et al., 2011.
Outward Focus (OF) (4)	West and Farr, 1990; Nijssen *et al.,*2006;Patterson *et al.,* 2005, , Lone Jon Ander et al., 2011
Reflexivity (RFY) (4)	West, 1996,2000;Patterson *et al.,.,* 2005, , Lone Jon Ander et al., 2011
D. Rational Goal	
Clarity of Organizational Goals (OG) (8)	Hunter *et al.,*2007; Chang, 2008; Cott ,1995; Patterson *et al.,* 2005 , Lone Jon Ander *et al.,* 2011, Van Gundy 1988, Martin *et al.,* 2003, , Dixit Gopal Krishna *et al.,*2011
Efficiency (EFY) (2)	Ostroff and Schmitt,1993;Patterson *et al.* ,2005
Efforts (EFT) (2)	McCaol et al.,, 1987;Patterson *et al.,* 2005
Performance feedback (PFB) (3)	Annett,1969 and Kopelmann 1986;Patterson *et al.,* 2005
Pressure to produce(PP) (5)	Teresa 1998; Teresa, 1993 ; Teresa, 1998; Taira , 1996 ;Patterson *et al.,*2005
Quality (QT) (4)	Deming,1986; Hackman and Wageman ,1995;Patterson *et al.,.*2005, Lone Jon Ander et al., 2011

3.2 Reliability of Scale

Based on the 16 shortlisted variables the questionnaire/tool was framed similar to OCM (Patterson et al.,, 2005). The finalized tool has got 16 scales to study the organizational climate. The reliability of these scales was established. Through pilot test, cronbach's alpha (α) values were calculated and are placed in table 03. All the values corresponding to 16 scales were above 0.7 except Autonomy & Reflexivity. These two were also 0.67 i.e. nearing 0.7 hence considered reliable. For the scales on efficiency the cronbach's alpha was improved from 0.53 to 0.749 and similarly for the scales on quality the cronbach's alpha was improved from 0.162 to 0.678 by dropping one item in each scale. The items dropped may not be fitting in the specific organization climate of the laboratory.

3.3 Measure of Innovation

Innovation was measured as self-reports of innovativeness by managers/scientists in various departments of the laboratory during 2011 to 2013. The scale used has got 7 items based on similar studies done elsewhere in past. (Bunce & West, 1995; West & Anderson, 1996; Jon Ander Lone, 2011) This scale was also tested for its reliability as mentioned in table 03 and Cronbach's alpha value was found to be 0.843 which is considered highly reliable.

3.4 Questionnaire

Data was collected using a customized questionnaire for climate & innovation. Questionnaire has 3 sections A, B & C. Section 'A' is for general information about the respondent, section 'B' has got 16 scale for organization climate having 76 items & section 'C' is for innovation scale having 7 items. All the scales of section B & C have been tested for reliability through Cronbach's alpha value.

3.5 Data Collection & Analysis

Besides Cronbach's alpha (α) value for all the scales the collected data includes descriptive statistics i.e. mean & standard deviation for each scale and correlation amongst each scale/ determinant as mentioned in table no. 03. Further regression analysis was also done to generate the regression model and the summary of the model is placed in table 5.

3.6 Respondents

Respondents (populations) include all the 135 officers including scientists from ADRDE. So far 71 responses have been collected and survey is still going on. The present results are based on 71 responses only. Response rate so far is 100% as we have approached 71 officers only so far.

3.7 Innovation Markers

Available and accessible secondary data mainly the various innovation markers from the laboratory were also considered for analysis. Out of various innovation markers listed from literature, a few markers like collaborative research, number of publications, annual training expenditure, national level recognition etc. were studies at the laboratory.

3.8 Case Studies

Two cases studies were framed and both were studied w.r.t secondary data available from the laboratory in the form of innovation markers and also role of various determinants/organization climate variables in explaining innovation in the laboratory.

4. Results & Discussion

Table 3 – Descriptive statistics, scale reliability and correlation analysis

S. No		Cronbach's Alpha	Mean	SD	Correlation														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Innovation	0.843	3.33	.68															
2	Autonomy	0.67	2.55	.52	.193														
3	Integration	0.83	2.78	.56	.399	.271													
4	Involvement	0.819	2.83	.51	.543	.360	.56												
5	Supervisory Support	0.854	3.06	.48	.425	.27	.48	.53											
6	Training	0.823	3.06	.55	.165	.30	.30	.50	.64										
7	Flexibility	0.872	2.75	.51	.550	.27	.39	.72	.57	.53									

8	Formalization	0.743	2.98	.44	.026	-.17	.04	.10	.09	.17	.17									
9	Tradition	0.781	2.60	.56	-.62	-.23	-.44	-.47	-.42	-.35	-.47	-0.78								
10	Outward focus	0.758	2.91	.49	.521	.04	.44	.56	.38	.22	.50	.32	-.44							
11	Reflexivity	0.676	2.82	.47	.544	.23	.28	.59	.49	.35	.67	.25	-.44	.66						
12	Clarity of Organizational Goals	0.91	3.03	.67	.547	.26	.48	.59	.47	.45	.59	.22	-.59	.64	.63					
13	Efficiency	0.749	2.76	.58	.446	.25	.42	.56	.38	.29	.53	.18	-.33	.45	.55	.41				
14	Efforts	0.853	2.86	.59	.521	.16	.48	.52	.37	.30	.58	.32	-.45	.45	.60	.44	.67			
15	Performance Feedback	0.86	2.97	.61	.657	.23	.58	.70	.50	.50	.69	.19	-.58	.51	.65	.67	.54	.71		
16	Pressure to Produce	0.767	2.66	.53	.603	.35	.43	.64	.44	.34	.52	.017	-.41	.49	.54	.52	.33	.51	.64	
17	Quality	0.678	2.95	.613	.602	.23	.61	.64	.67	.51	.56	.17	-.48	.60	.55	.66	.26	.40	.66	.67

4.1 Innovation Climate Model

The following innovation climate model based on the 16 shortlisted determinants of organizational climate for pubic funded R&D laboratory as independent variable & innovation as dependent variable is proposed as shown in table 4:

Table 4 - Innovation Climate Model

Independent Variables	Dependent Variable
Autonomy (AN), Integration (INT), Involvement (INV), Supervisory Support (SS), Training (TRG), Formalization (FMZ), Tradition (TRD), Flexibility (F), Outward Focus (OF), Reflexivity (RFY), Clarity of Organizational Goals (OG) , Efficiency (EFY), Efforts (EFT), Performance feedback (PFB), Pressure to produce(PP), Quality (QT)	Independent Variables except formalization and tradition are positively related to Dependent Variable- Innovation

The data was collected using reliable scales (α>0.7) and were analyzed using descriptive statistics- mean & standard deviation, correlation and regression. All the climate parameters have positive correlation with innovation except for tradition as expected. All the parameters are positively related with each other except with tradition in all cases and formalization. These details are furnished in table 4.

Further, the dependent model was analyzed statistically through regression. The β (Beta) value were also calculated for each variable to generate a regression equitation with 16 climate variable and 01 dependent variable i.e. innovation. The summary of the model is placed in table 5. The strength of the model can be assured by very high value of R2 (R2 >0.715) which means that the 16 variables are able to explain more than 70% of the climate for innovation.

Table 5 - Summary of regression model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2
1	.845[a]	.715	.630	.41671	.715	8.452	16	54

4.2 Markers of Innovation

In literature, several parameters are mentioned as a measure of innovation in the organization. Some of these measures include number of new products/services introduced to market, time-to-market, improvement in product features, cost and performance, patent disclosures, number of publications, number of innovative ideas, effort and commitment, collaboration, training, etc. All these parameters may not be available, accessible or quantifiable in any organization. In the laboratory under study a few innovation markers were available. The data in table 6, 7, 8 & 9 very clearly shows that the expenditure in collaboration, number of publications, and expenditure on training and national level recognition has increased gradually. The increase in these parameters has resulted because of improvement in climate for innovation in the laboratory. This can also be understood from the two case studies reported.

4.3 Case Studies

Two case studies were done on development projects done in recent past. One was on development of heat stabilized narrow fabrics and the second one was on development of flexible envelope material with 5 years life for Aerostat. This was done in the laboratory to validate the various identified climate parameters and their role in organizational climate for innovation (Vikas, 2014).The two case studies reviled that the shortlisted climate determinants are able to foster environment in the laboratory for innovation as also suggested by the data analysis & where in it was shown that the laboratory is improving fast in recent year's w.r.t. climate for innovation. This is indicated through improvement in a few available innovation markers. The key success factors (KSF) for the two cases are furnished in table 10 ahead.

Table 6 - Collaborative Research through Academics (2004-2013)

Years	Nos. of CARS Project Sanctioned	Total Cost, (Rs. In lacs)	Details for last two blocks of 03 Years
2004	03	11.17	
2005	04	20.58	15 CARS Project
2006	04	8.68	Rs 59.30 lacs
2007	04	18.87	
2008	02	19.65	19 CARS Project
2009	10	88.36	Rs 172.34 lacs
2010	07	64.33	
2011	04	36.30	12 CARS Project
2012	04	117.08	Rs 190.71 lacs
2013 (Up to October 2013)	04	37.33	

Table 7 –Number of Publications

Year	No. of Papers Written	Combine Number of Papers for 03 year block
2008-09	0	
2009-10	01	06
2010-11	05	
2011-12	17	45
2012-13	08	
2013-14	21	

Table 8 – Annual Training Expenditure (In Indian Rupees)

Years	In house Courses- Continuing Education Programme (CEP)	Outside Courses	Conferences/Seminars	PhD/ M.Tech	Total
2008-09	63000	168691	61500	0	293191
2009-10	93148	193100	86296	0	372544

2010-11	282300	90134	165000	0	537434
2011-12	45000	182897	290500	146175	664572

Table 9 – National level recognition in last few years to ADRDE

Years	Number of Award	No. of Recipient	Amount to ADRDE team (Rs in lacs)
2013	02	09	06
2012	02	13	5.20
2011	03	03	1.60
2010	02	04	0.95
2007 to 2009	NIL	NIL	NIL

5. Conclusions

In the study, the detailed literature review followed by short-listing of the parameters through survey and discussions with experts identified the determinants of climate for innovation in the R&D laboratory. The 16 scales for organization climate & 01 scale for innovation were found reliable on trial run ($\alpha > 0.7$). The innovation climate model based on the analysis of data collected so far in case of public R&D laboratory based on 16 determinants seems to be reasonable ($R2 > 0.7$) and also supported by the two case studies as indicated by the key success factors (KSF). The available innovation markers support the findings of case studies & also indicate the improving climate in the laboratory for innovation in recent years. This model may further be refined after further data collection using the already designed tool. The two case studies indicated that innovation can be nurtured through control on climate i.e. the identified determinants.

6. Limitations

The climate in the laboratory for innovation was so far evaluated based on available literature, discussion with experts. The model generated is so far based on partial survey which is being refined further through further data collection which is already under progress. Further, validation has been done with limited available innovation markers and two case studies. In future it is proposed to validate the model with further data collection and some more case studies & innovation markers.

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